Advanced Hydrogen/Methanol Utilization Technology Demonstration

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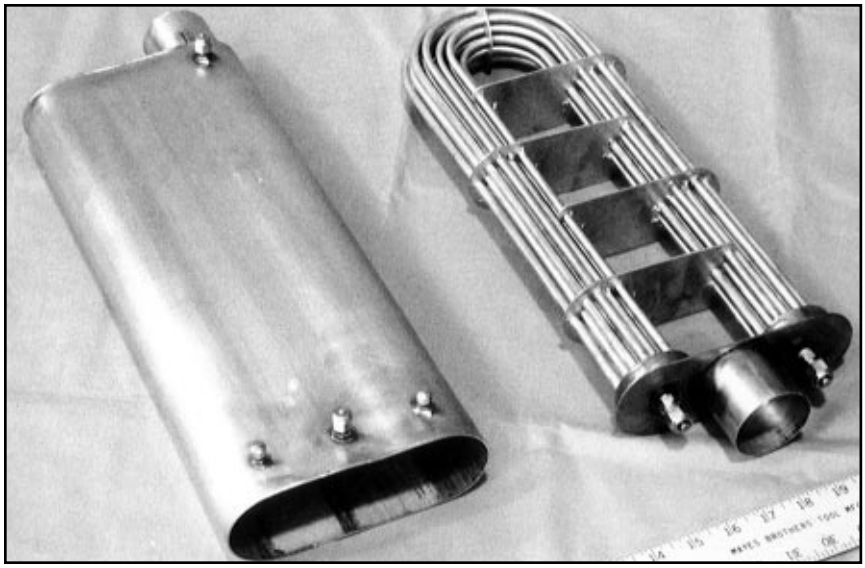
Objective

To generate hydrogen onboard a methanol (MeOH) vehicle and use it to reduce cold-start emissions by starting the engine on pure hydrogen and burning additional hydrogen directly on the catalyst to heat it rapidly.



Methanol reforming reactor

Approach

MeOH is cracked over a catalyst to form a hydrogen-rich gaseous product. The heat for this process is supplied from the exhaust gases after the engine reaches operating temperature. The hydrogen is concentrated by a membrane separator and stored in a small pressure vessel for the next cold start. The waste gases are burned in the engine. Bench tests of the catalyst and separator were followed by vehicle cold-start emissions tests (Cold 505 = Phase 1 of the Federal Test Procedure [FTP]).

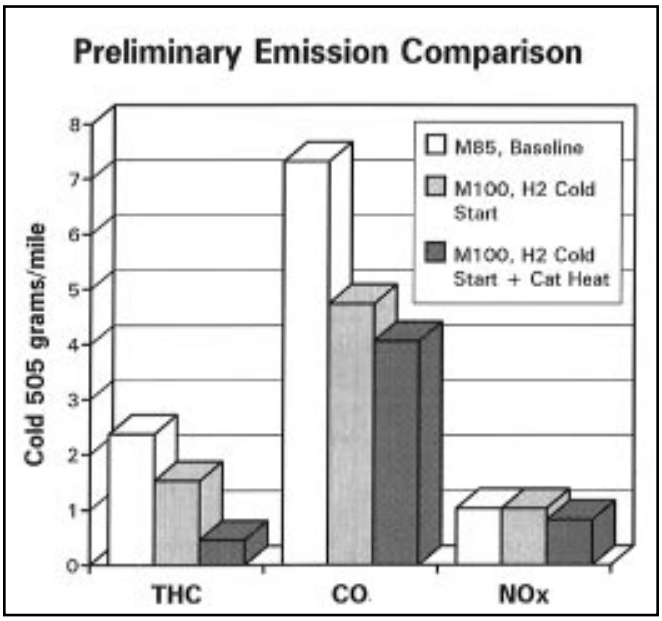
Accomplishments

Hydrogen allows an engine to start quickly and idle cleanly during the first 20 seconds of the FTP. In the engine, hydrogen is burned with extra air (lean burn), which results in surplus oxygen in the exhaust stream. Extra hydrogen is then injected into the exhaust flow just upstream from the exhaust catalyst. The hydrogen and oxygen combine on the catalyst's surface and provide several kW of heating power. Without the hydrogen injection, the catalyst outlet temperature during the FTP reaches 250°C in 200 seconds. With hydrogen injection, this time decreases to 55 seconds.

The emissions reductions achieved are shown below. The baseline is M85 (85% MeOH, 15% gasoline) to ensure cold starting. The effects of hydrogen cold start alone and hydrogen cold start with a hydrogen-heated catalyst are shown separately. M100 (pure MeOH) was used in the hydrogen tests because M85 will foul the cracker. Fourier transform infrared (FTIR) analysis during the Cold 505 test shows significant reductions in aldehyde emissions caused by the hydrogen cold start. Further aldehyde reductions are achieved by heating the catalyst with hydrogen.

Future Direction

Communicating the results of this study to engine and auto manufacturers presents additional options for meeting failure emissions standards. In parallel with this work, Hydrogen Consultants, Inc., and Honda are working together in their high altitude laboratory in Denver to explore this technology further. Hydrogen Consultants, Inc., and Colorado State University welcome collaboration with the automotive industry to bring advanced alternative fuels technology to fruition.



Publications

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